Analysis of the Dynamics of Tidal Flats Using Synthetic Aperture Radar Imaging

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LONG-TERM GOALS

The long term goal of this proposed project is to improve our understanding of the dynamics of tidal flats, in particular how the domain of tidal flats has changed overall from a historical perspective and what are the dynamical changes during a tidal cycle as well as during the spring and neap tides. Satellite observations, both historical and new data from a variety of microwave and electro-optical sensors, will be acquired for the experimental phases at the Skagit and Willapa tidal flats.

OBJECTIVES

The specific scientific objectives of this study, to be carried out in collaboration with the Tidal Flat investigators, are:

a) To describe the geomorphologic changes using historical satellite imagery.

b) To improve our understanding of the dynamics of tidal flats during various phases of the tidal cycle using satellite SAR image data.

c) Support the on-going experimental measurement phases with new satellite data acquisitions.

d) To determine how SAR signatures can be related to the sedimentary and geotechnical properties of the tidal flat.

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e) To generate high resolution wind maps for improved understanding of the wind forcing variability and turbulence over tidal flats.

f) To provide spatial snapshots of the dynamics during the flooding and ebbing stages governing tidal flats.

g) Radar imaging of the wave field and translation of the images into snapshots of “elevation maps" of the surface using both satellite and ship or floating platform based sensors.

h) Measurements of the wave field and the atmosphere above the wave field using ASIS buoys to generate data sets that could be compared to wave models and radar both in the spectral and phase-resolved domains, and leads to a better understanding how the wind profile, fluxes, coefficient of drag vary with respect to differing wind and wave conditions.

i) Measurements of breaking using acoustic and microwave means as well as in-situ sensors locally.

APPROACH

CSTARS extracted from its archive seven SEASAT (1978) L-Band SAR images from 13 July to 19 August 1978. We still have to retrieve several historical RadarSat-1 and ENVISAT ASAR images from this area. We acquired 22 collects of both ascending and descending passes of TerraSAR-X including multi-polarizations and from RadarSat-1 we collected an additional ten images from mid-July to end of August in 2009. The new collections focused on the experimental phase of the Tidal Flats program. Together we have an extensive set of historical and new satellite SAR acquisitions of tidal flat dynamics at X-Band, C-Band and L-Band frequencies.

Our first steps will be to examine the temporal variability of tidal flat area with the extensive SAR data, in particular from a geo-morphological perspective. The satellite data spans more than 30 years of observations. In-situ measurements will help to provide context and will be compared to detected SAR images.

WORK COMPLETED

1) All historical and new satellite SAR images have been acquired.

RESULTS

Figure 1 shows a SEASAT L-Band SAR image of the Skagit River tidal flat region in 1978. The image was acquired about 2 hours before maximum flood tide was reached. The tidal front is clearly visible in this image as the bore-like feature is very rough and generates more backscatter return.

Figure 2 a RadarSat-1 C-Band SAR image of the same region acquired on 14 August 2009 at 14:10 UTC. This fine mode image has about 10 m resolution. The image was taken about 1 hour after ebb tide and the bottom of tidal flat region around the river mouth is visibly exposed.

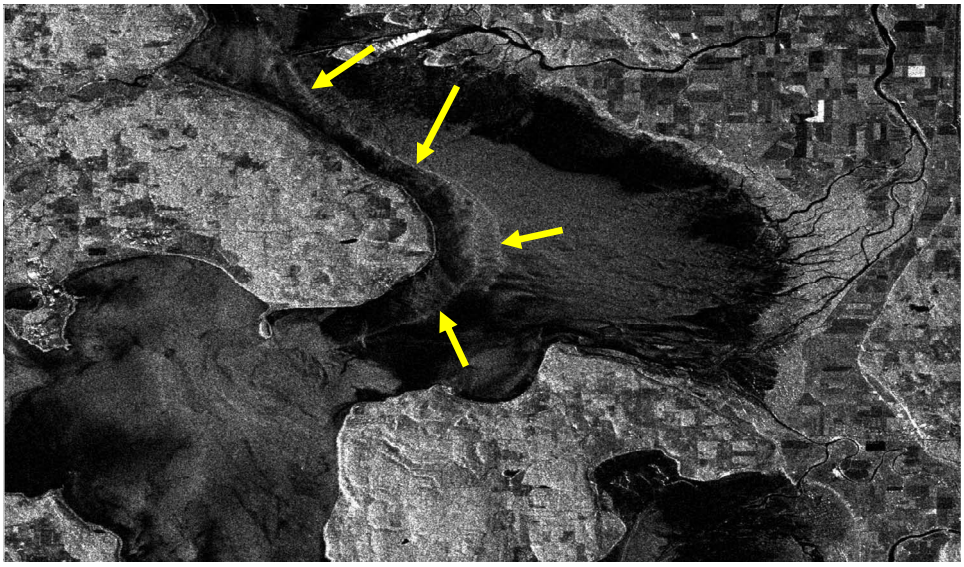

Figure 1: A Seasat SAR image from 16 August 1978 shows the Skagit River tidal flat 2 hours before maximum flood is reached. The tidal front is easily visible in this image as a bright line (rough surface) which is indicated by arrows.

Figure 2: A RadarSat-1 fine beam mode SAR image from 14 August 2009 shows the Skagit River tidal flat about 1 hour after ebb tide occurred. The bottom of the tidal flats is easily visible in the vicintiy of the river mouth.

IMPACT/APPLICATIONS

The new high resolution SAR data with multi-polarization capabilities and up to 1 meter resolution is ideal way to explore tidal flat, river mouth and inlet dynamics, in particular for estimating bathymetry

and identifying bathimetric features. Also with advanced satellite antenna configurations it is possible to derive surface vector currents. These applications will be come useful in areas where vessel traffic would interfer with in-situ instrumentations that have surface expressions.

TRANSITIONS

None. Project just started.

RELATED PROJECTS

None. Project just started.